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(54) Abstract Title
An electrical system for an electronic fuel injection motorcycle

(57) A power management module for use in an electronic fuel injection motorcycle divides the motorcycle's lectrical loads and associated circuitry into groups which are each assigned a priority level. Power is supplied from a generator via a rectifier to supply the group of loads having the highest priority which may include for example, the engine control unit, sensor, fuel injector and control relay. When the power requirement of this group of loads is met, the group of loads having the next highest order of priority is supplied with power. This group of loads may include a fuel pump, signalling lamps and horn. The arrangement allows the motorcycle to be started manually more easily if the battery is flat and prevents the operation of loads affecting the operation of the engine whilst it is running.

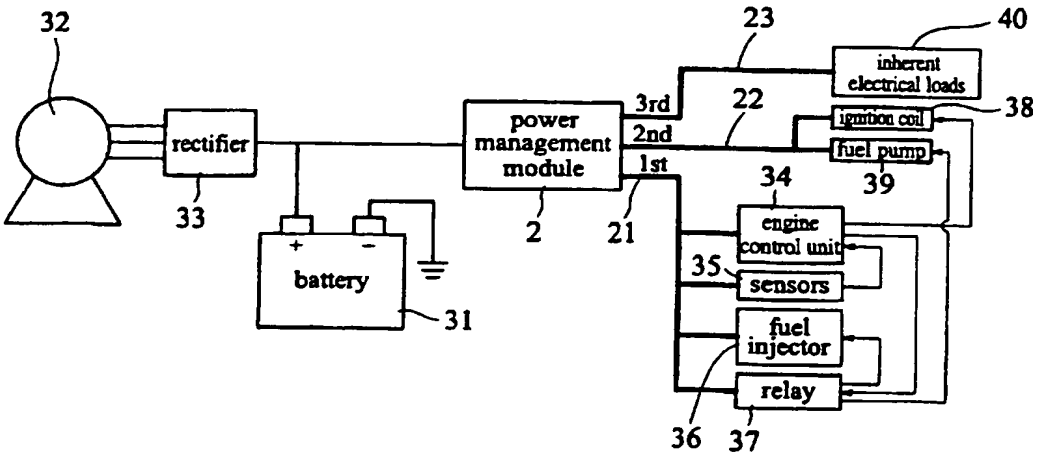

FIG.3

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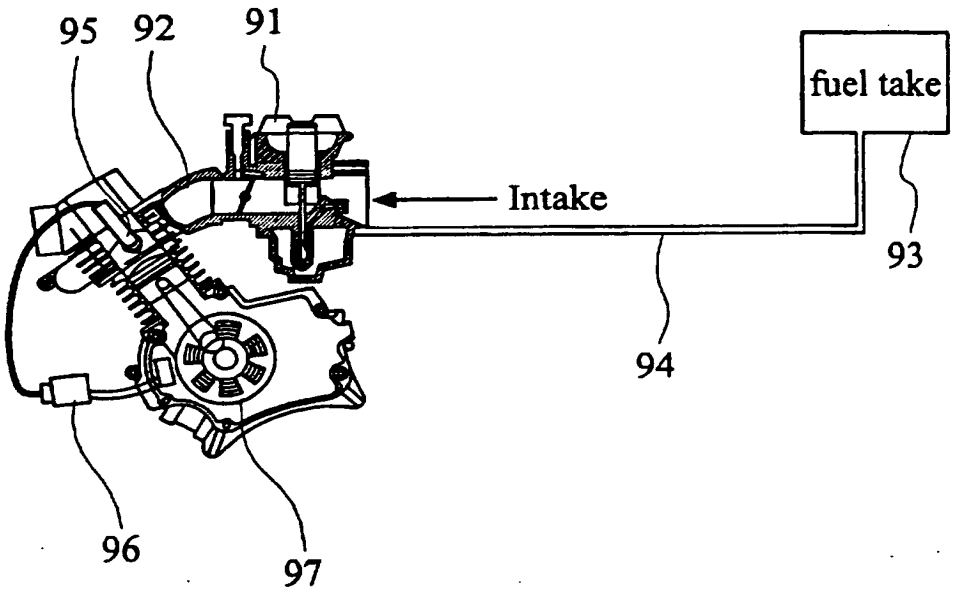

FIG.1
(PRIOR ART)

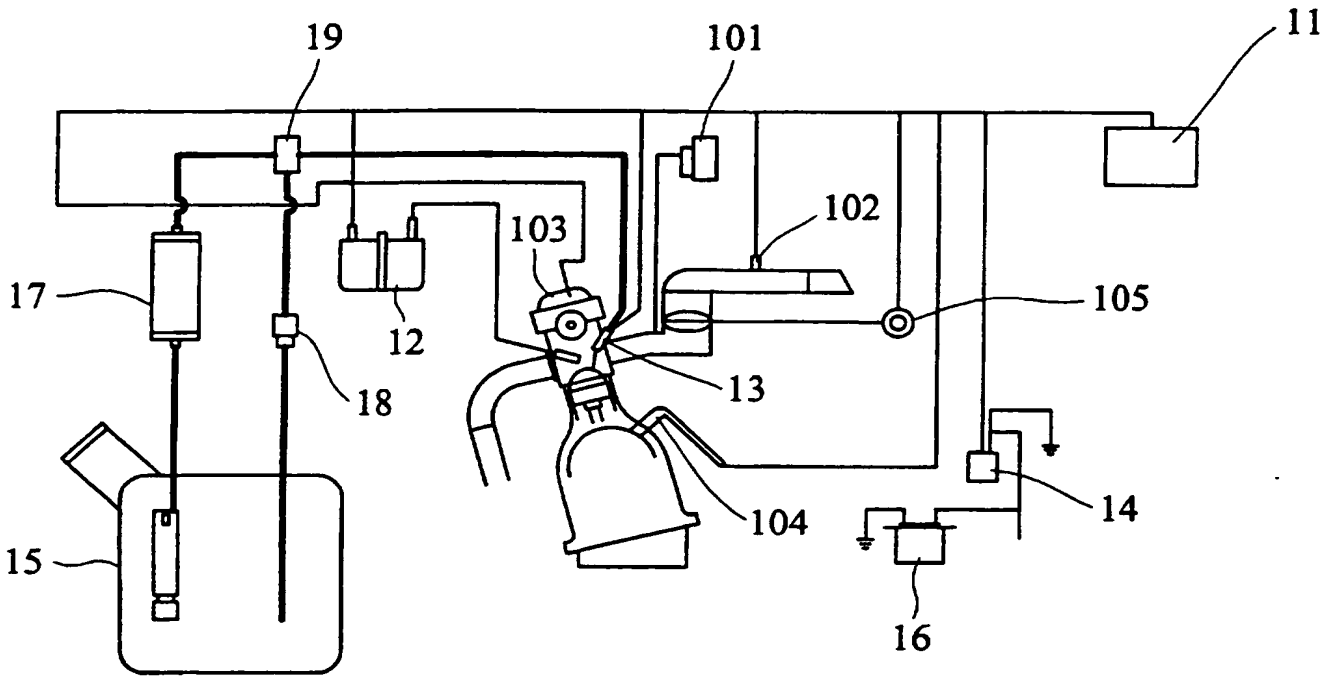

FIG.2
(PRIOR ART)

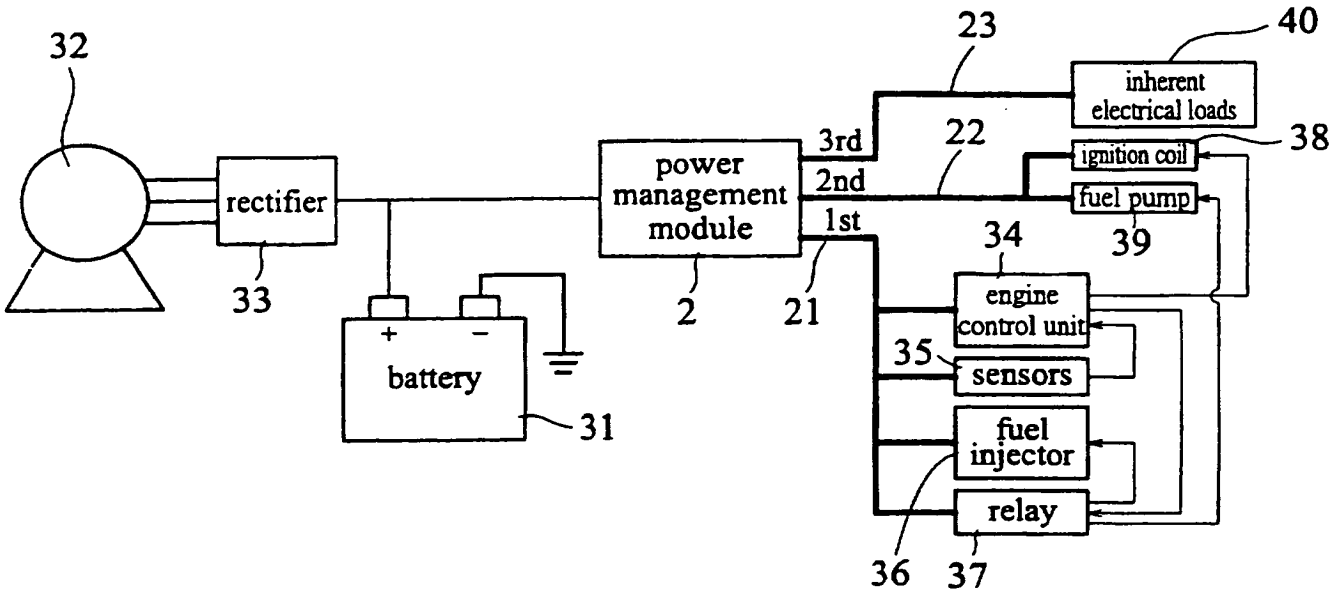

FIG.3

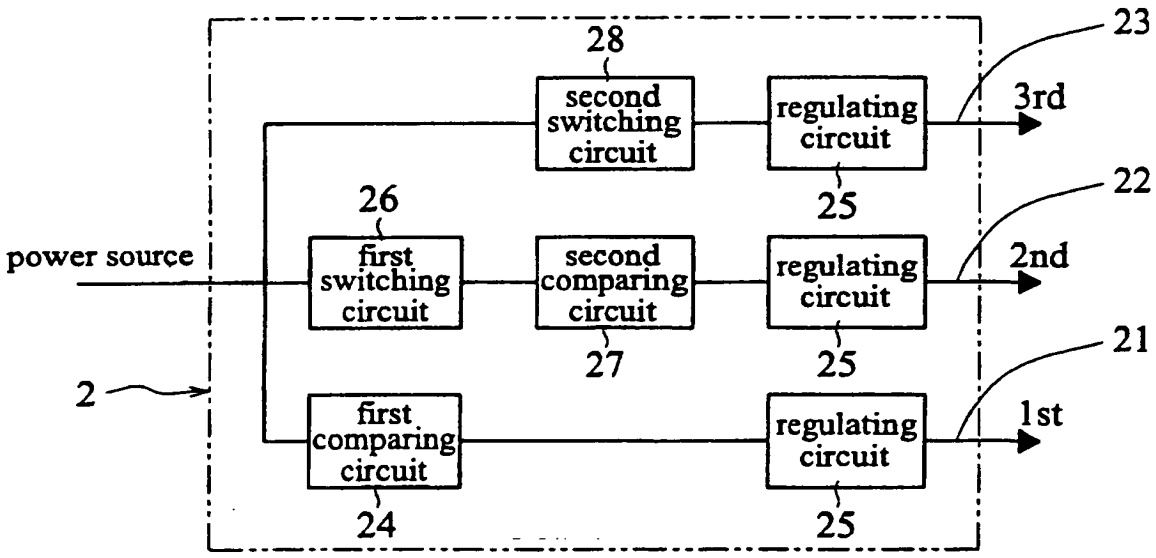

FIG.4

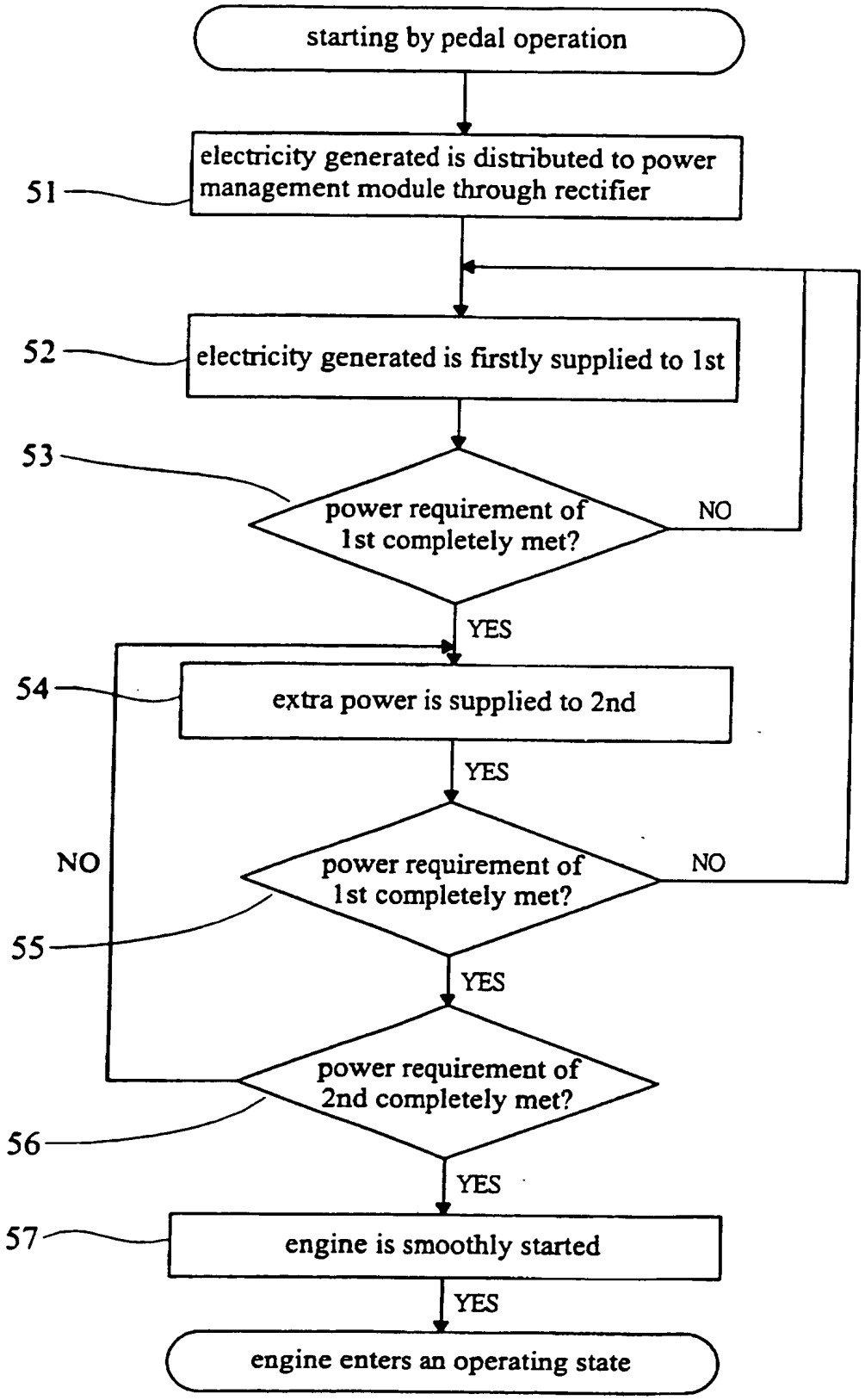

FIG.5

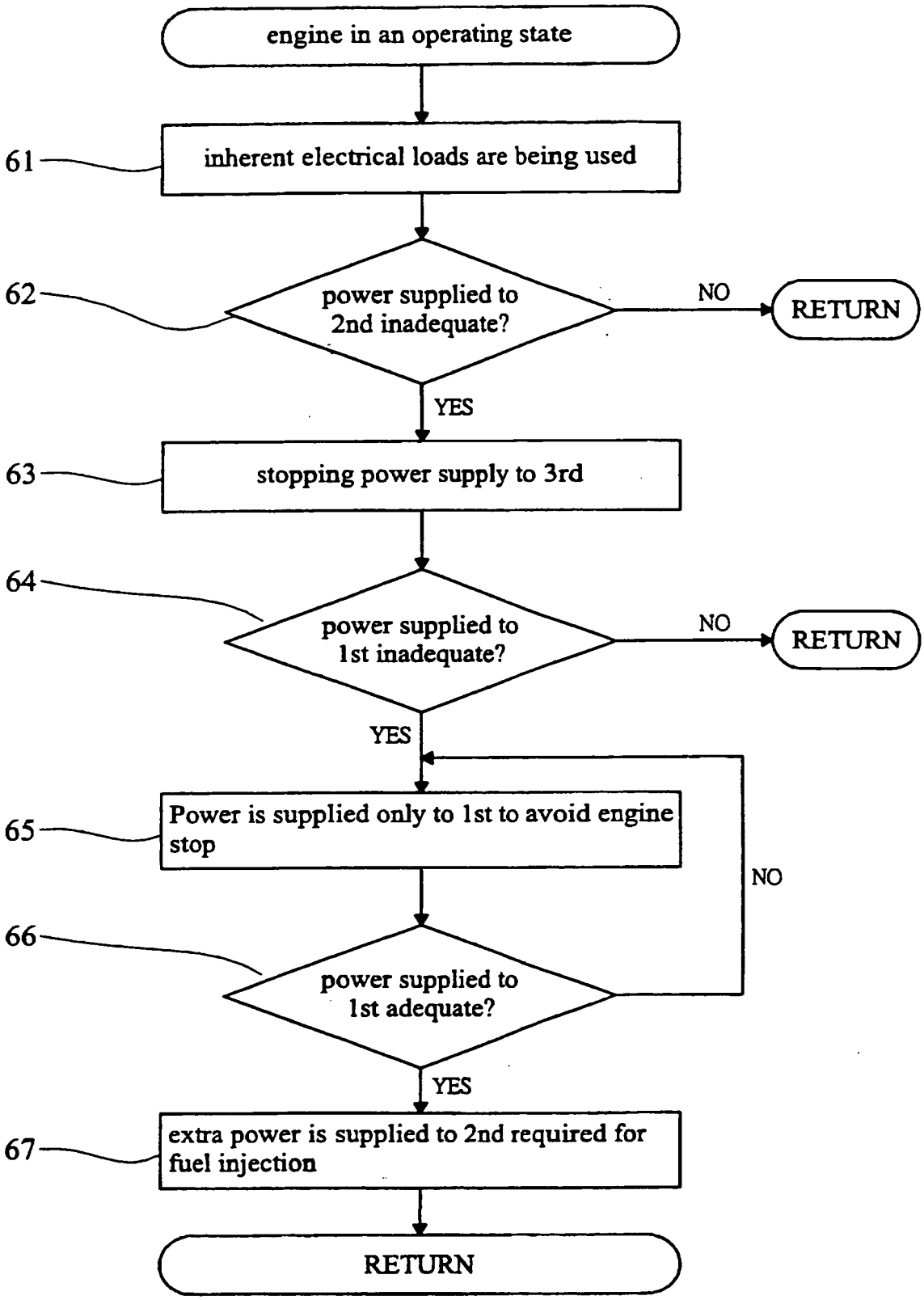

FIG.6

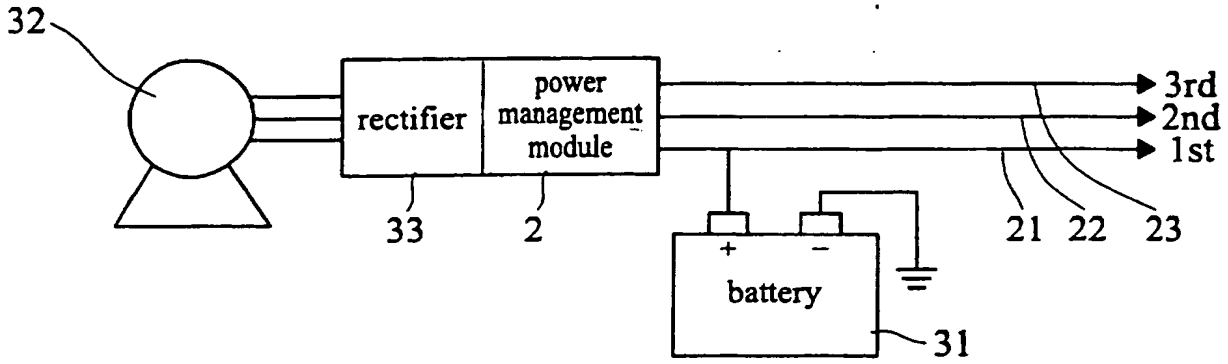

FIG.7

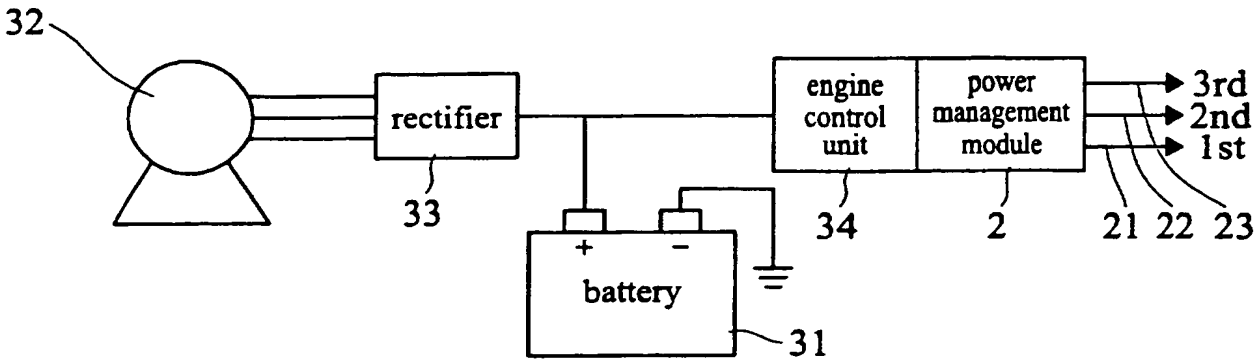

FIG.8

ELECTRICAL SYSTEM FOR ELECTRONIC FUEL-INJECTION MOTORCYCLE

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to an electrical system for electronic fuel-injection motorcycle, and more specifically, it relates to an electrical system for electronic fuel-injection motorcycle of which the power supply priority can be set up.

DESCRIPTION OF THE RELATED ART

Fig. 1 is a schematic diagram of a traditional engine using carburetor 91, of which the amount of fuel supply is determined by the amount of intake air supply. When the air supply in the fuel conduit 92 is more, the quantity of fuel flowing from the fuel tank 93 through the fuel conduit 94 to the carburetor 91 will also be more. This way of fuel supply is of purely mechanical type without any sensor or controller to control the fuel injection quantity. The ignition module of the plug 95 is an alternating capacitor-discharge igniting system 96 (also referred to as CDI). The power of the CDI is directly supplied by the generator. Thus, when electricity in the battery is exhausted, the engine may also be started with the help of human power through such as pedal operation (applying a kicking force to the kick lever of a motorcycle).

The advantages of the above mentioned carburetor are as follows:

1. Simple structure, low cost.

2. When electricity in the battery is exhausted, the engine can be started with the help of human power.

Its disadvantages includes:

1. Fuel injection timing and ignition timing cannot be controlled, resulting in larger fuel consumption.

2. Incomplete combustion due to failure in accurately calculating and controlling the fuel supply results in air pollution besides larger fuel consumption.

3. Since air/fuel mixture produced by the carburetor 91 must first flow through fuel conduit 92 before being injected into the combustion chamber, some mixture inevitably remains in fuel conduit 92, which also results in larger fuel consumption and causes air pollution.

Fig. 2 is a schematic diagram for a conventional electronic fuel-injection control system with an engine control unit 11 (microprocessor), an ignition coil 12, an injector 13, a relay 14, a fuel pump 15, a battery 16, an intake pressure sensor 101, an intake temperature sensor 102, an engine fuel temperature sensor 103, a crank angle sensor 104 and a throttle position sensor 105.

The working principle for the above conventional electronic fuel-injection control system is explained as follows. All signals received by the above sensors are input to the engine control unit 11 which processes the input signals and sends appropriate signals to the relay 14 to control the operation of the ignition coil 12 and the fuel injector 13. Thus, it is possible to control the ignition timing, the fuel injection timing of the fuel

injector and the starting of the fuel pump 15. The thin lines in the figure represent electrical circuits, and the thick lines indicate the fuel pipes in which are provided a fuel cleaner 17, a fuel rail 19 and a fuel pressure regulating valve 18.

As the engine must be started with the control of the engine control unit 11, the engine control unit 11 should always be in a workable state. If the voltage of engine control unit 11 is too low or the power supply of engine control unit 11 is insufficient, it would be unable to start the engine.

The advantage of this kind of electrical system for electronic fuel-injection motorcycle resides in that ignition timing and fuel injection timing are all controlled by the engine control unit 11 resulting in a good combustion effect, thereby reducing the fuel consumption and air pollution. The drawback of this kind of electrical system is that its construction is complicated. Besides, since the power of the only power source namely battery 16 must be distributed among the engine control unit 11 and various inherent electrical loads of a motorcycle such as head lights, signal lights, brake lights and horns, the engine cannot be started when electricity in the battery 16 is insufficient or exhausted. In such a situation, even with the help of human power, the engine can hardly be started because the limited electricity produced cannot be supplied to the engine control unit 11 by first priority.

SUMMARY OF THE INVENTION

The primary object of this invention is to provide an electrical

system for electronic fuel-injection motorcycle which permits the engine to be started, when electricity in the battery is insufficient or exhausted, by supplying the limited electricity produced by the generator with the help of human power to the engine control unit by first priority. Besides, when a motorcycle is running, the operation of the motorcycle will not be affected as a result of low voltage in the engine control unit even if various electrical loads (lights, horn) of the motorcycle are used, because the available electricity is always supplied to the engine control unit by first priority.

In order to achieve the above object, this invention provides an electrical system for electronic fuel-injection motorcycle, including a generator which may be driven by an engine or human power so as to generate electricity; a rectifier connected to the generator for converting the electricity generated by the generator into direct current; and a battery connected to the rectifier for storing the direct current converted by the rectifier; a plurality of electrical circuits each connected between the rectifier and an engine control unit, or between the rectifier and the remaining loads of the motorcycle. This electrical system for electronic fuel-injection motorcycle further includes a power management module which divides the plurality of electrical circuits into at least two power supply groups of different power supply priorities including a first priority circuit group connected between the rectifier and an engine control unit, and a second priority circuit group, and which functions to have the converted direct current supplied first to said first priority circuit group,

and then to said second priority circuit group after the power requirement of said first priority circuit group is completely met, and subsequently to the remaining priority circuit groups one by one according to their power supply priorities.

In the above electrical system for electronic fuel-injection motorcycle, the plurality of electrical circuits may be divided into three power supply groups of different power supply priorities including a first priority circuit group supplying power to the engine control unit, a sensor, a fuel injector and a control relay; a second priority circuit group supplying power required for ignition; and a third priority circuit group supplying power to the inherent electrical loads of a motorcycle including head lights, signal lights, brake lights and horns.

In the above electrical system for electronic fuel-injection motorcycle, the plurality of electrical circuits may also be divided into three power supply groups of different power supply priorities including a first priority circuit group supplying power to the engine control unit, a sensor, a fuel injector and a control relay; a second priority circuit group supplying power required for a fuel pump; and a third priority circuit group supplying power to the inherent electrical loads of a motorcycle including head lights, signal lights, brake lights and horns

In the above electrical system for electronic fuel-injection motorcycle, the plurality of electrical circuits may be divided into two power supply groups of different power supply priorities including a first priority circuit group supplying power to the engine control unit, a sensor,

a fuel injector and a control relay; and a second priority circuit group supplying power to the inherent electrical loads of a motorcycle including head lights, signal lights, brake lights and horns

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, advantages and characteristics of this invention will be described more clearly with the descriptions of the preferred embodiments in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic diagram of a traditional engine using carburetor.

Fig. 2 is a schematic diagram of a control system for a conventional electronic fuel-injection.

Fig. 3 is a schematic electrical circuit diagram illustrating an electrical system for electronic fuel-injection motorcycle according to the first embodiment of this invention.

Fig. 4 is the functional block diagram of the power management module shown in Fig. 3.

Fig. 5 is a flow chart showing the way of performing power supply control upon starting an engine by pedal operation.

Fig. 6 is a flow chart showing the way of performing power supply control when an engine is running.

Fig. 7 is a schematic electrical circuit diagram illustrating an electrical system for electronic fuel-injection motorcycle according to the second embodiment of this invention.

Fig. 8 is a schematic electrical circuit diagram illustrating an

electrical system for electronic fuel-injection motorcycle according to the third embodiment of this invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 3 is a schematic electrical circuit diagram illustrating an electrical system for electronic fuel-injection motorcycle according to the first embodiment of this invention.

The electrical system according to the first embodiment includes a generator 32, a rectifier 33, a battery 31, a power management module 2 and a plurality of electrical circuits connected, respectively, between the rectifier 33 and an engine control unit 34 (also referred to as ECU), various sensors 35, a fuel injector 36, a relay 37, an ignition coil 38, a fuel pump 39, and various inherent electrical loads 40 of a motorcycle including head lights, signal lights, brake lights and horns etc.

The generator 32 is driven by an engine or by human power through such as pedal operation to generate electricity which is then converted into direct current and supplied to the battery 31 and the power management module 2.

The power management module 2 is an independent member directly connected to the rectifier. It divides the plurality of electrical circuits into three power supply groups of different power supply priorities including a first priority circuit group 21, a second priority circuit group 22, and a third priority circuit group 23. The first priority circuit group 21 supplies power to engine control unit 34, sensors 35, fuel injector 36 and control relay 37. The sensors 35 include an intake

pressure sensor, an intake temperature sensor, an engine fuel temperature sensor, a crank angle sensor, a throttle position sensor etc. The second priority circuit group 22 supplies power to ignition coil 38 and fuel pump 39. The third priority circuit group 23 supplies power to the inherent electrical loads 40 of a motorcycle including head lights, signal lights, brake lights and horns.

Fig. 4 is the functional block diagram of the power management module 2 shown in Fig. 3. As illustrated in Fig. 4, the power management module 2, connects with the first priority circuit group 21, the second priority circuit group 22, and the third priority circuit group 23. The first priority circuit group 21 also includes a first comparing circuit 24 and a regulating circuit 25. The second priority circuit group 22 also includes a first switching circuit 26, a second comparing circuit 27 and a regulating circuit 25. The third priority circuit group 23 also includes a second switching circuit 28 and a regulating circuit 25. Its working principle is illustrated hereunder.

This invention mainly controls the power when there is no power in the battery. Its working process is illustrated below:

With reference to Figs. 4 and 5, the way of performing power supply control by the power management module 2 upon starting an engine by pedal operation is described below. In Fig. 5, "1st", "2nd", "3rd" denote the first, second, and third priority circuit groups 21, 22, 23, respectively.

51: When there is no power in the battery, the engine can be started by use of human power (by pedal operation) and the electricity generated

by the generator 32 will be distributed to the power management module 2 through the rectifier 33.

52: As the first and second switching circuits 26, 28 of the second and third priority circuit groups 22, 23 are both in an OFF state before the power supply is applied, the electric current necessarily flows through the first priority circuit group 21 to engine control unit 34 (ECU), injector 36 and relay 37, and those sensors 35 relating to the starting of the engine.

53: The power will be fully supplied to the first priority circuit group 21 until the first comparing circuit 24 judges that the power requirement of the first priority circuit group 21 is completely met.

54: When power requirement of the first priority circuit group 21 is completely met, the first switching circuit 26 will be turned on and extra power will then be supplied to the coil 38 and the fuel pump 39 through the second priority circuit group 22.

55: The first comparing circuit 24 determines whether the power requirement of the first priority circuit group 21 is completely met. If not, the first switching circuit 26 will be turned off and power will be supplied to the first priority circuit group 21. Otherwise, power will be supplied to the second priority circuit group 22.

56. The second comparing circuit 27 determines whether the power requirement of the second priority circuit group 22 is completely met. If not, it will continue to supply power to this second priority circuit group 22.

57: When the power requirements in both the first and the second

priority circuit groups 21 and 22 are completely met, the engine will be smoothly started and enters an operating state.

With reference to Figs. 6 and 4, the way of performing power supply control by the power management module 2 when the engine is in an operating state is described below. In Fig. 6, "1st", "2nd", "3rd" denote the first, second, and third priority circuit groups 21, 22, 23, respectively.

61: In an operating state, power are normally supplied to the first, second and third priority circuit groups 21, 22, 23, and may be further supplied to various inherent electrical loads 40 of the motorcycle, for example head light, signal light, brake light, horn etc. through the third priority circuit group 23.

62: The second comparing circuit 27 determines whether the power supplied to the second priority circuit group 22 is inadequate. If not, then power supply to the third priority circuit group 23 will continue. If the power is inadequate, then it proceeds to 63 in the flow chart.

63: The second switching circuit 28 is switched off and power supply to the third priority circuit group 23 is stopped.

64: The first comparing circuit 24 determines whether the power supplied to the first priority circuit group 21 is inadequate. If not, then power will be supplied to the second priority circuit group 23. Otherwise, it will proceed to 65 in the flow chart.

65: The first switching circuit 26 is turned off and power supply to the second priority circuit group 22 is stopped. Power will be supplied only to the first priority circuit group 21 to avoid causing the breakdown

of the ECU which may lead to engine stop.

66: The first comparing circuit 24 determines whether the power supply in the first priority circuit group 21 is adequate. If not, it returns back to 65 in the flow chart. Otherwise, it proceeds to 67 in the flow chart.

67: The first switching circuit 26 is turned on, and extra power exceeding the requirement of the first priority circuit group 21 is supplied to the second priority circuit group 22 so as to establish the pressure required for fuel injection.

From the above description, it can be understood that when the power in the battery is exhausted, power supply priority can be set up with the help of the power management module 2 so as to manage power supply appropriately. On the other hand, when there is sufficient power in the battery, the provision of the power management module 2 will not lead to an obstruction in power supply.

Summing up the above, the advantages of this invention may be summarized as follows:

1. When there is no power in the battery, the engine can be started with the help of human power and power will be firstly supplied to the ECU, thereby starting the engine.

2. During ignition of the engine, over usage of the electrical loads of the motorcycle will not lead to a low voltage in the ECU or an engine stop.

3. This invention possesses the advantages of a fuel-injection

motorcycle: Ignition timing and fuel injection timing are accurately controlled by the ECU, thereby reducing the fuel consumption and air pollution.

The fuel pump in the above embodiment functions electronically, however, the fuel pump in some motorcycle functions mechanically. In such circumstances, the second priority circuit group need not supply power to the fuel pump.

Besides, if AC capacitor-discharge ignition method, instead of an ignition coil, is adopted, then power need not be supplied to the fuel pump through the second priority circuit group as power will be directly supplied by another coil set of the generator.

Further, if DC capacitor-discharge ignition method is used, power will be supplied by the second priority circuit group.

Summarizing the above description, power supply priorities in the electrical system for an electronic fuel-injection motorcycle may be determined according to the below list:

Model of the motorcycle	First Priority circuit group	Second Priority circuit group	Third Priority circuit group
Ignition Coil + Electronic Fuel Pump	Engine Control Unit, Sensor, Relay, Injector	Ignition Coil, Electronic Fuel Pump	Lights (including head light, signal light, brake light) and horn
DC Capacitor Discharge Ignition + Electronic Fuel Pump	Engine Control Unit, Sensor, Relay, Injector	DC Capacitor Discharge Ignition, Electronic Fuel Pump	Lights, horn
AC Capacitor Discharge Ignition +	Engine Control Unit, Sensor, Relay, Injector	Electronic Fuel Pump	Lights, horn

Electronic Fuel Pump			
Ignition Coil + Mechanical Fuel Pump	Engine Control Unit, Sensor, Relay, Injector	Ignition Coil	Lights, horn
DC Capacitor Discharge Ignition + Mechanical Fuel Pump	Engine Control Unit, Sensor, Relay, Injector	DC Capacitor Discharge Ignition	Lights, horn
AC Capacitor Discharge Ignition + Mechanical Fuel Pump	Engine Control Unit, Sensor, Relay, Injector	Lights, horn	

With reference to Fig. 7, the power management module 2 is provided within the rectifier and the rectifier 33 in this embodiment, thereby simplifying the structure of the electronic components of the whole system.

Alternatively, with reference to Fig. 8, the power management module 2 may also be provided within the engine control unit 34 (ECU), thereby simplifying the structure of the electronic components of the whole system.

While the preferred embodiments and examples of the present invention have been described using specific terms, such description is for illustrative purpose only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

CLAIMS

1. An electrical system for an electronic fuel-injection motorcycle, comprising:

a generator which may be driven by an engine or human power so as to generate electricity;

a rectifier connected to the generator for converting the electricity generated by the generator into direct current; and

a battery connected to the rectifier for storing the direct current converted by the rectifier;

a plurality of electrical circuits each connected between the rectifier and an engine control unit, or between the rectifier and the remaining loads of the motorcycle;

characterized by further comprising a power management module

which divides the plurality of electrical circuits into at least two power supply groups of different power supply priorities including a first priority circuit group connected between the rectifier and an engine control unit, and a second priority circuit group, and

which functions to have the converted direct current supplied first to said first priority circuit group, and then to said second priority circuit group after the power requirement of said first priority circuit group is completely met, and subsequently to the remaining priority circuit groups one by one according to their power supply priorities.

2. The electrical system for electronic fuel-injection motorcycle according to claim 1 wherein said power management module is an

independent unit.

3. The electrical system for electronic fuel-injection motorcycle according to claim 1 wherein said power management module is provided within the rectifier.

4. The electrical system for electronic fuel-injection motorcycle according to claim 1 wherein said power management module is provided within the engine control unit.

5. An electrical system for electronic fuel-injection motorcycle comprising:

a generator which may be driven by an engine or human power so as to generate electricity;

a rectifier connected to the generator for converting the electricity generated by the generator into direct current; and

a battery connected to the rectifier for storing the direct current converted by the rectifier;

a plurality of electrical circuits each connected between the rectifier and an engine control unit, or between the rectifier and the remaining loads of the motorcycle;

characterized by further comprising a power management module

which divides the plurality of electrical circuits into three power supply groups of different power supply priorities including a first priority circuit group supplying power to the engine control unit, a sensor, a fuel injector and a control relay; a second priority circuit group supplying power required for ignition; and a third priority circuit group

supplying power to the inherent electrical loads of a motorcycle including head lights, signal lights, brake lights and horns; and

which functions to have the converted direct current supplied first to said first priority circuit group, and then to said second priority circuit group after the power requirement of said first priority circuit group is completely met, and finally to the third priority circuit group after the power requirement of said second priority circuit group is completely met.

6. The electrical system for electronic fuel-injection motorcycle according to claim 5 wherein the second priority circuit group further supplies power required for a fuel pump.

7. An electrical system for electronic fuel-injection motorcycle comprising:

a generator which may be driven by an engine or human power so as to generate electricity;

a rectifier connected to the generator for converting the electricity generated by the generator into direct current; and

a battery connected to the rectifier for storing the direct current converted by the rectifier;

a plurality of electrical circuits each connected between the rectifier and an engine control unit, or between the rectifier and the remaining loads of the motorcycle;

characterized by further comprising a power management module which divides the plurality of electrical circuits into three power

supply groups of different power supply priorities including a first priority circuit group supplying power to the engine control unit, a sensor, a fuel injector and a control relay; a second priority circuit group supplying power required for a fuel pump; and a third priority circuit group supplying power to the inherent electrical loads of a motorcycle including head lights, signal lights, brake lights and horns; and

which functions to have the converted direct current supplied first to said first priority circuit group, and then to said second priority circuit group after the power requirement of said first priority circuit group is completely met, and finally to the third priority circuit group after the power requirement of said second priority circuit group is completely met.

8. An electrical system for electronic fuel-injection motorcycle comprising:

a generator which may be driven by an engine or human power so as to generate electricity;

a rectifier connected to the generator for converting the electricity generated by the generator into direct current; and

a battery connected to the rectifier for storing the direct current converted by the rectifier;

a plurality of electrical circuits each connected between the rectifier and an engine control unit, or between the rectifier and the remaining loads of the motorcycle;

characterized by further comprising a power management module

which divides the plurality of electrical circuits into two power supply groups of different power supply priorities including a first priority circuit group supplying power to the engine control unit, a sensor, a fuel injector and a control relay; and a second priority circuit group supplying power to the inherent electrical loads of a motorcycle including head lights, signal lights, brake lights and horns; and

which functions to have the converted direct current supplied first to said first priority circuit group, and then to said second priority circuit group after the power requirement of said first priority circuit group is completely met.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB 9905901.6
Claims searched: 1 to 8

Examiner: Glyn Hughes
Date of search: 18 May 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H2H (HDV, HSL, HBD, HBCB)

Int Cl (Ed.6): B60R 16/02, F02M 51/00, F02N 3/04, 11/08, H02J 7/14

Other: Online: WPI, JAPIO, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0811763 A2	(MITSUBA) see whole document	1-4, 8
X	US 5691576	(MINKS) see whole document	1-4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.